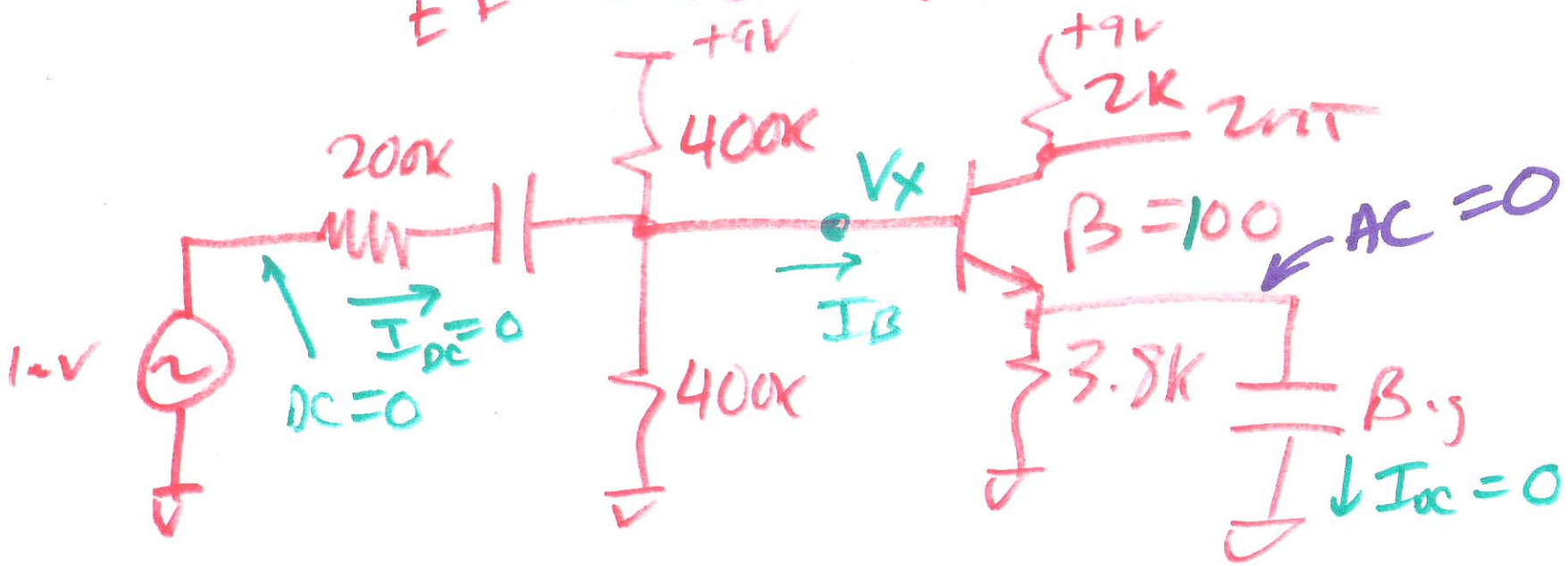
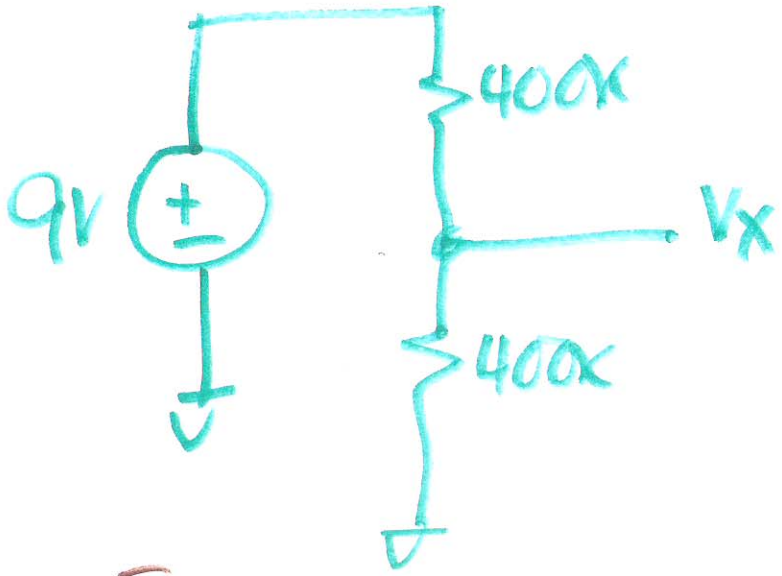
Lecture 23

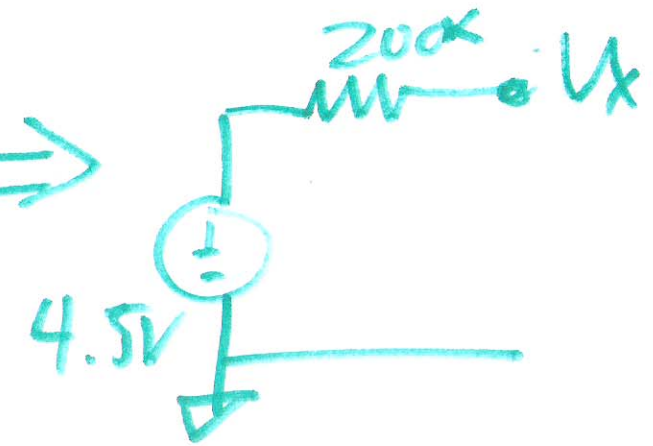
April 20, 2015

EE 320 Electronics I

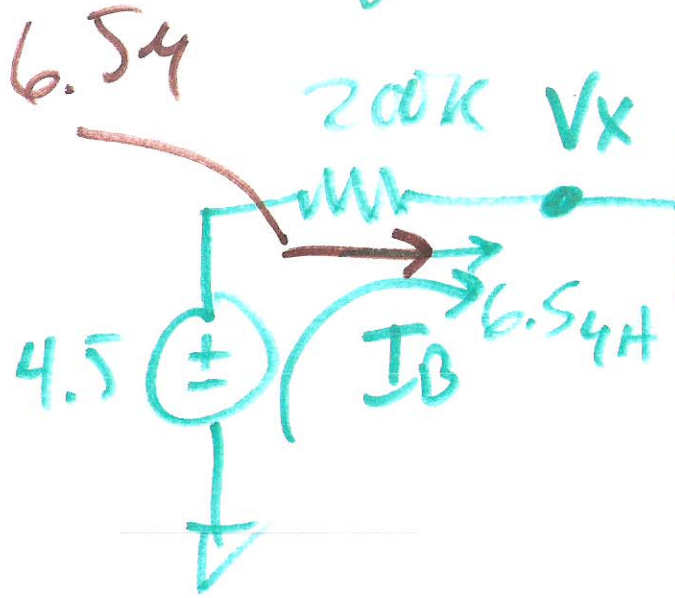




$\Rightarrow$



$$4.5 - I_B \cdot 200k - .7 - (\beta+1) I_B \cdot 3.8k = 0$$



$$I_E = 101 \cdot 6.54\mu A = 657.4\mu A$$

$$3.8 = I_B (200k + 101 \cdot 3.8k)$$

$$I_B = \frac{3.8}{583.8k} = 6.54\mu A$$

$$V_x = 4.5 - 6.54 \cdot 200k = 3.2V$$

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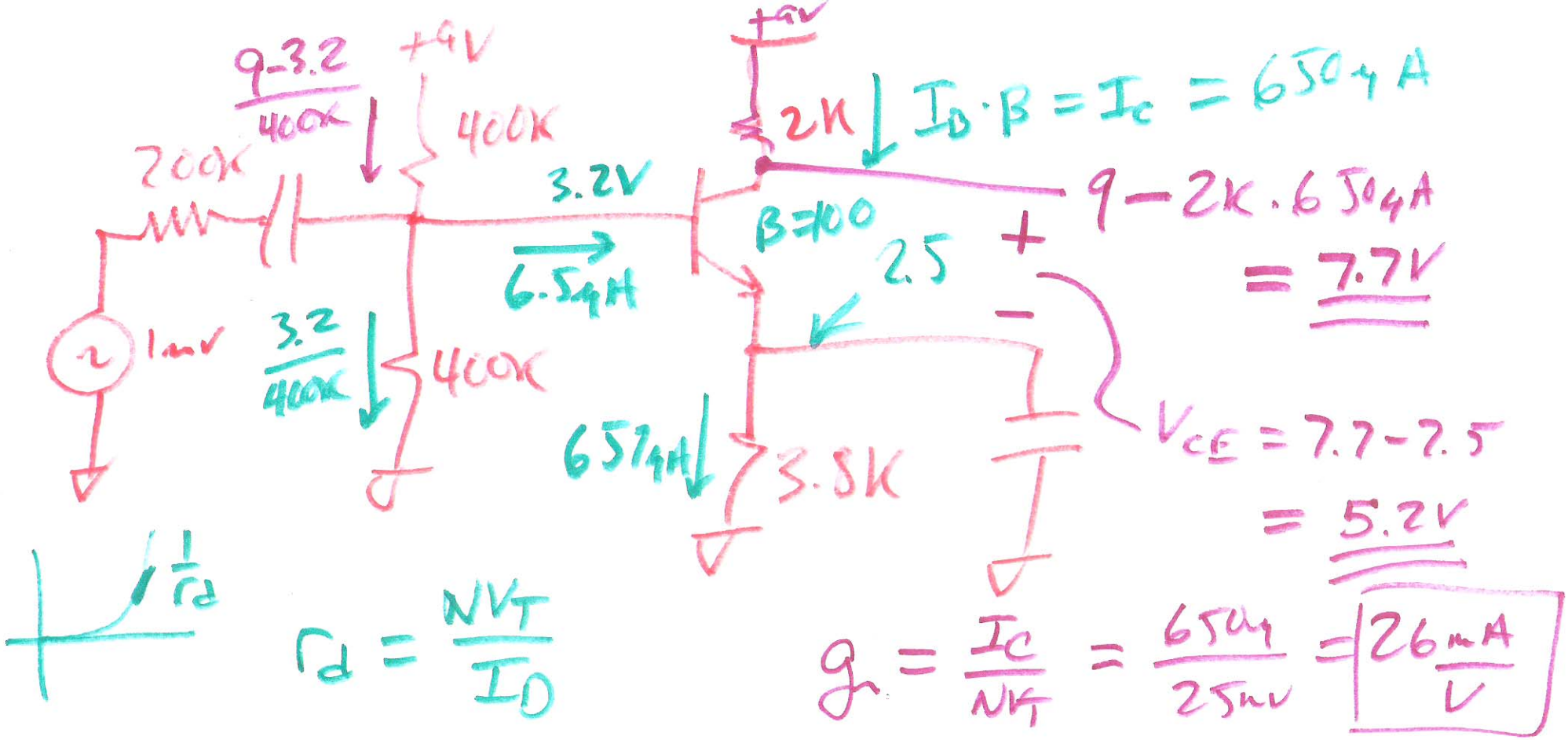
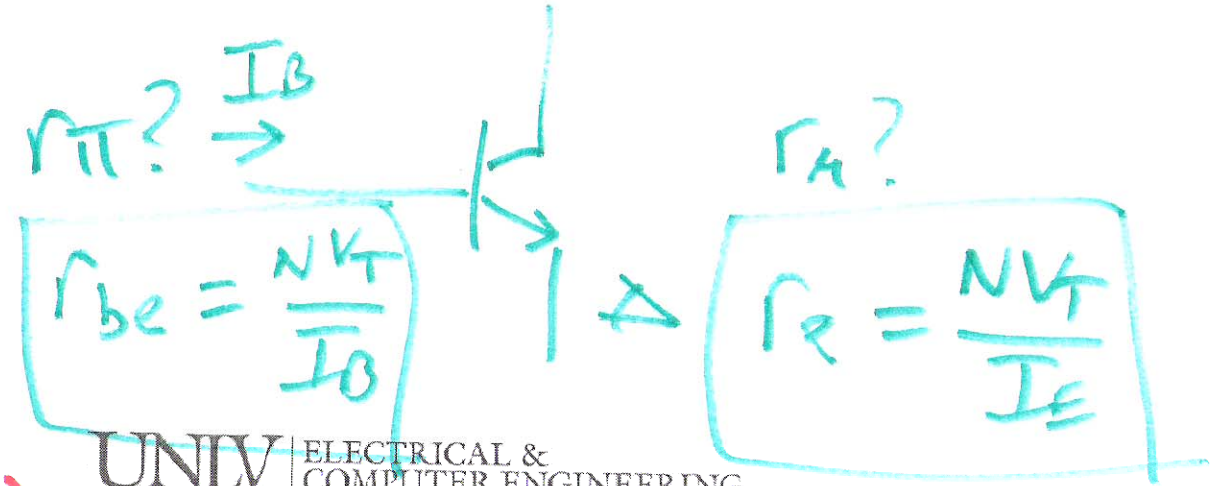
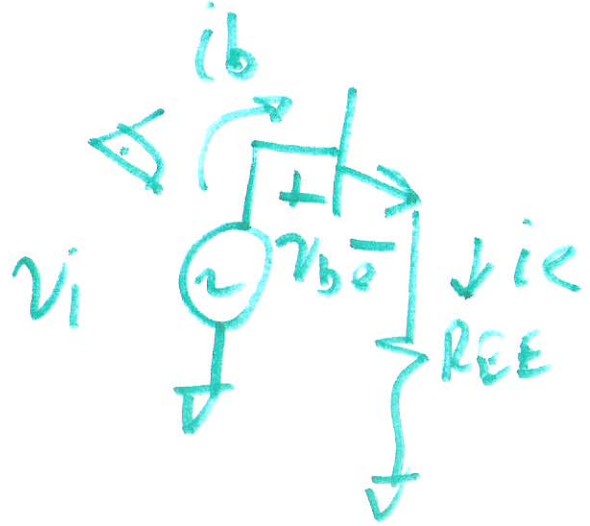

9-3.2
400K
+9V
400K
200K
3.2V
2K
$I_D \cdot \beta = I_C = 650\mu A$
$9 - 2K \cdot 650\mu A$
$= 7.7V$
$\beta = 100$
$650\mu A$
2.5
+
-
1mV
3.2
400K
400K
$650\mu A$
3.5K
$V_{CE} = 7.7 - 2.5$
$= 5.2V$
$\frac{1}{r_d}$
$r_d = \frac{NV_T}{I_D}$
$g_m = \frac{I_C}{NV_T} = \frac{650\mu}{25mV} = \frac{26mA}{V}$


r_π?
I_B
r_e?
$r_{be} = \frac{NV_T}{I_B}$
$r_e = \frac{NV_T}{I_E}$

AC



$$v_{be} = i_b \cdot r_{be} = i_b \cdot \frac{N V_T}{I_B}$$

$$v_{be} = i_e \cdot r_e = i_e \cdot \frac{N V_T}{I_E}$$

$i_e = i_b \cdot (\beta+1)$

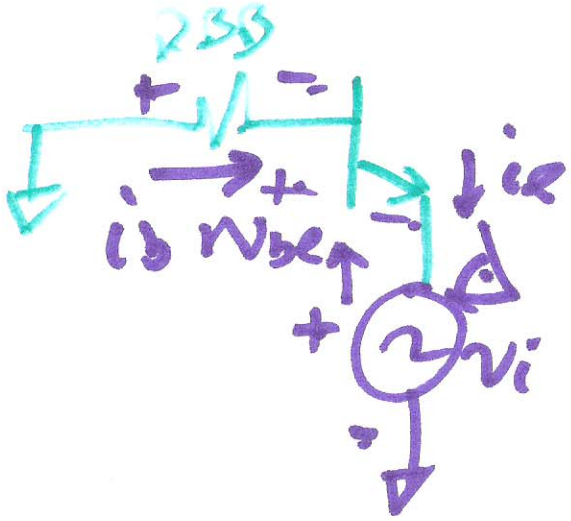
$I_E = I_B(\beta+1)$

$R_{\text{into base}}$

$$= \frac{v_i}{i_b} \Rightarrow v_i = v_{be} + i_e \cdot R_{EE}$$

$$= i_b \cdot r_{be} + i_b(\beta+1) \cdot R_{EE}$$

$$R_{\text{into base}} = \frac{v_i}{i_b} = r_{be} + (\beta+1) R_{EE}$$



v_i

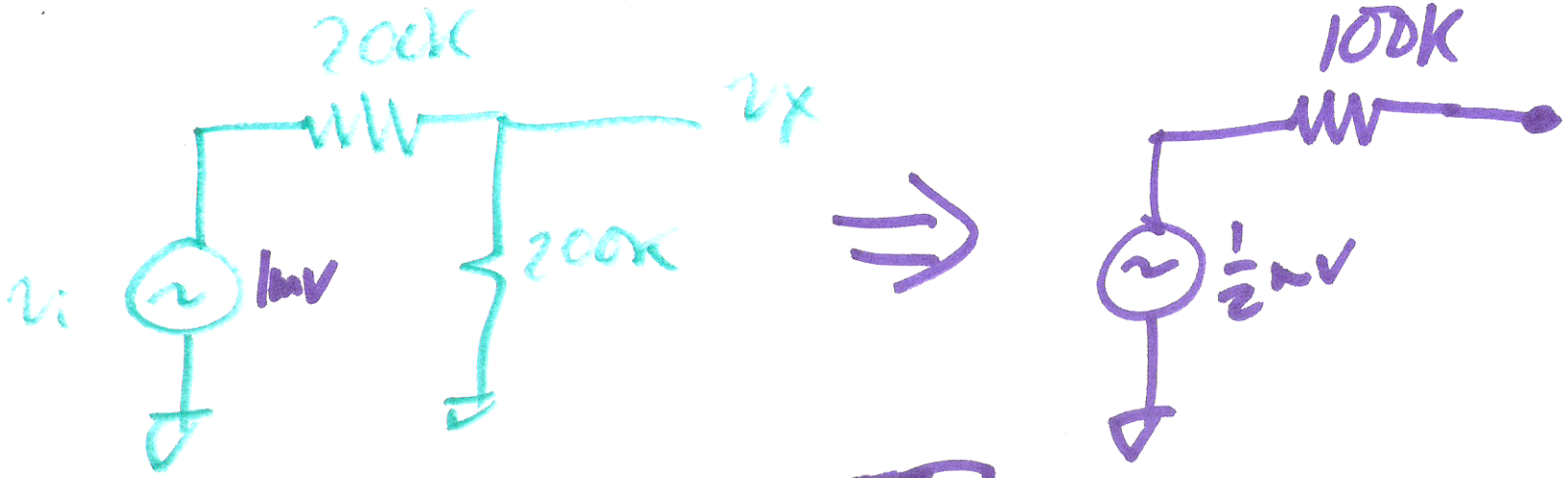
$$R_{w\,to\,emitter} = \frac{v_i}{-i_e}$$

$$v_i + v_{be} + i_b \cdot R_{BB} = 0$$

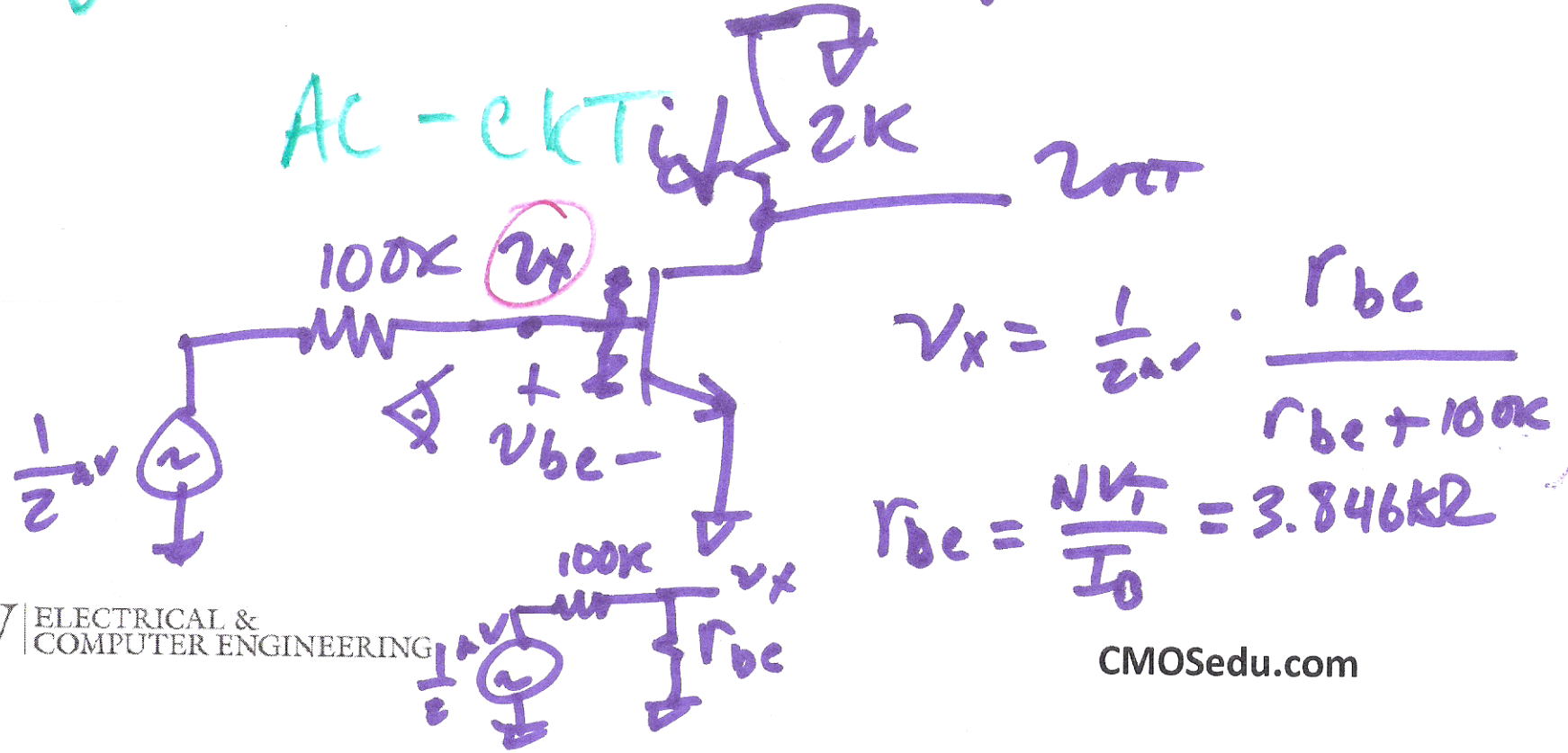
$$v_i = -r_e i_e - i_b R_{BB}, \quad i_b = \frac{i_e}{\beta+1}$$

$$= -i_e \left(r_e + \frac{R_{BB}}{\beta+1} \right)$$

$$\boxed{R_{w\,to\,emitter} = r_e + \frac{R_{BB}}{\beta+1}}$$



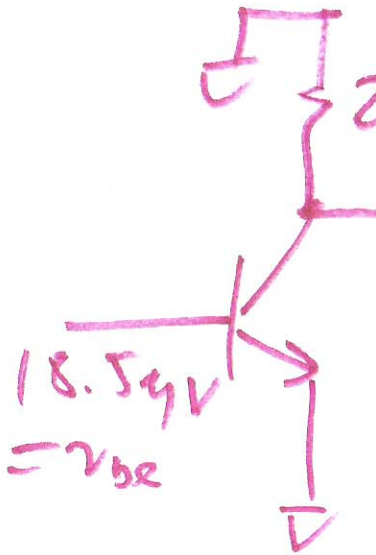
AC-CKT



$$v_x = \frac{1}{2}mV \cdot \frac{r_{be}}{r_{be}+100K}$$

$$r_{be} = \frac{NV_t}{I_D} = 3.846K\Omega$$

$$v_x = \frac{3.84}{103.84} \cdot \frac{1}{2} = \frac{18}{46.54\,V}$$



$i_c = v_{be} \cdot g_m = 18.54V \cdot$

$v_{out} = -i_c \cdot 2k$

$= -i_c \cdot 2k = 0.98\,V$

$i_c = 18.54V \cdot 26.5\,mV$

$= 490\,nA$

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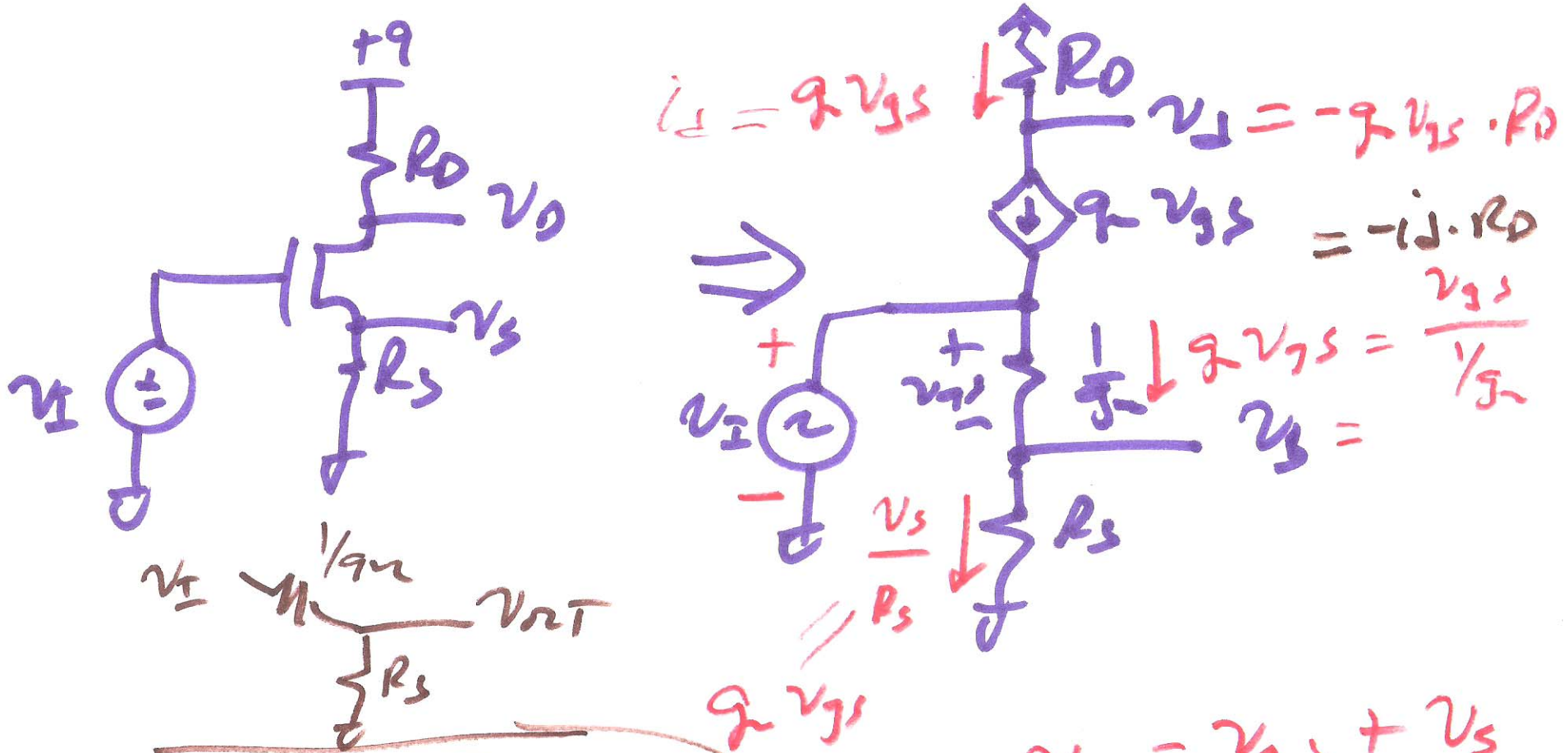


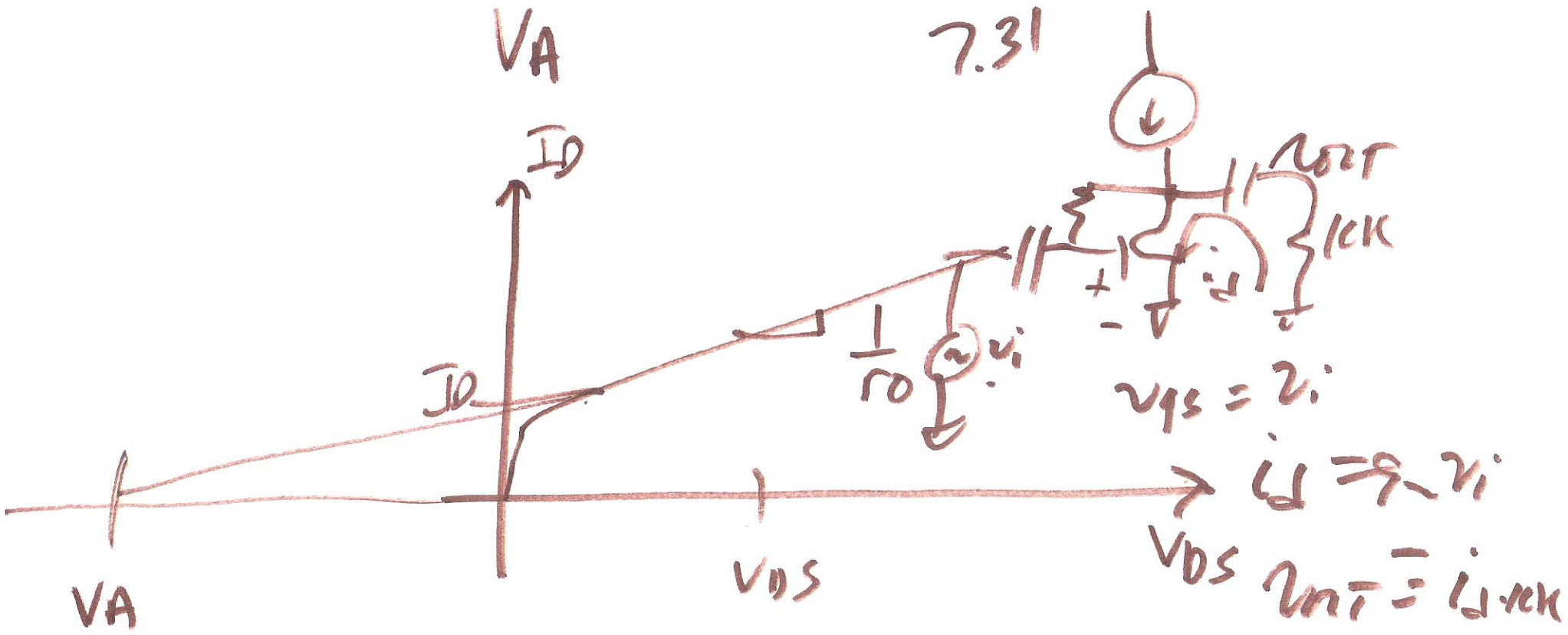
$$\frac{v_S}{v_I} = \frac{R_S}{1/g_m + R_S}$$

$$v_I = v_{gs} + v_S$$

$$= \frac{i_d}{g} + R_S \cdot i_d$$

$$v_S = i_d \cdot R_S$$

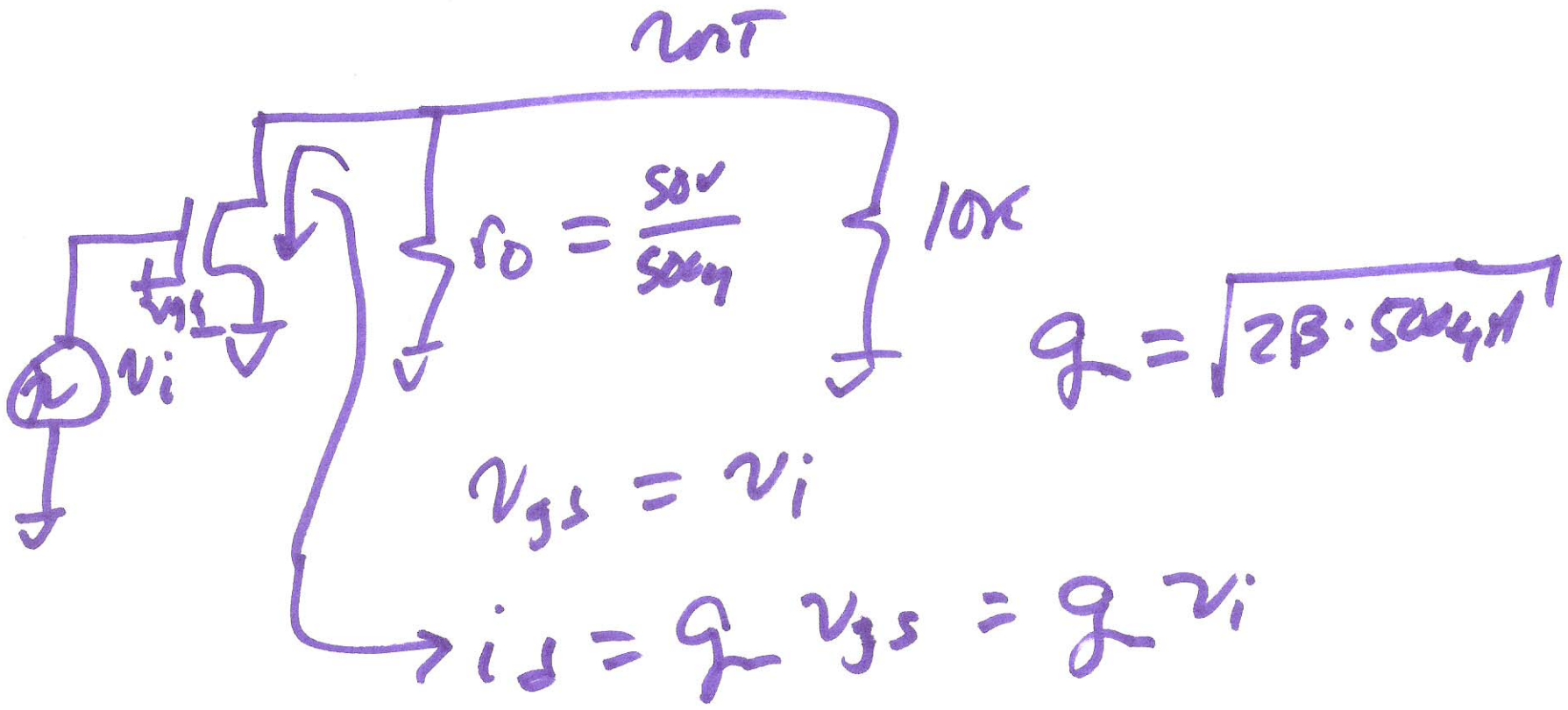
$$\frac{v_d}{v_I} = -\frac{R_D \cdot g_m}{\left(1/g_m \cdot g_m + g_m R_S\right) g_m}$$



$$V_A >> V_{DS}$$

$$\left(\frac{V_A}{I_D}\right)^{-1} = \frac{1}{r_o} = \boxed{r_o = \frac{V_A}{I_D}} \qquad \lambda = \frac{1}{V_A}$$

$\frac{v_{out}}{v_i}$



$$v_{out} = -i_d \cdot (r_o \| 10K)$$

$$= -g_m v_i (r_o \| 10K)$$

$$\frac{v_{out}}{v_i} = -g_m (r_o \| 10K)$$